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New Species of *Culicoides* from High Altitudes in the Colombian Andes (Diptera: Ceratopogonidae) [1]

By Willis W. Wirth and Vernon H. Lee [2]

No previous accounts of *Culicoides* exist from the Andean highlands of Colombia; furthermore, until the present, only seven species of *Culicoides* have been known from all of Colombia (Forattini, 1957; Wirth and Blanton, 1959). In this paper, we are describing nine new species from that country, all collected in the high, cool elevations of the Andes Mountains. One of these species occurs in such numbers and attacks human beings so severely that it is a serious pest. Affinities of these species are of particular interest and will be noted under the individual species. Generally these species show many more similarities to the *Culicoides* occurring in the North and Central American Temperate Zone than to those known from the tropical lowlands of Colombia. In this connection, it is important to note that the genus is not known to occur in the temperate southern part of South America, and thus it must be concluded that the Andean fauna has been derived from the North American continent.

[1] These observations were made during studies on arboviruses in Colombia with support in part from the Universidad del Valle and the Rockefeller Foundation.

[2] Wirth: Entomology Research Division, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C.; Lee: staff member, Rockefeller Foundation, Ibadan, Nigeria.

In 1964 and 1965, the junior author had the opportunity to collect in three distinct sites in the western and central ranges of the Colombian Andes in climates considered temperate to subalpine.

One site was the Finca Carpenteria in the municipality of El Tambo, Department of Cauca, on the eastern slope of the western cordillera at an elevation of 2500 m. In this area, patches of temperate hardwood forest surrounded by grasslands covered the slopes and crests of the mountains. Collections of *Culicoides* were made in one patch of forest with the aid of light traps and a Shannon tent trap.

A second collecting site (pl. 2: top) was located in the central cordillera at Lago Buey (also known locally as Lago San Rafael), 15 km east of the town of Puracé, Department of Cauca, in what is referred to as the Paramo de Puracé. This site was near the edge of a shallow lake at one side of a paramo meadow at 3250 m. Only human bait collections were made in the open, wet, grassy meadow. Also near this site at 3320 m, 18 km east of Puracé, a light trap was operated in a small cluster of trees on the edge of the paramo meadow.

A third site (pl. 2: bottom) was located in the central cordillera near the Paramo de Puracé in an area that has a distinctly different ecology. There, 28.4 km east of Puracé at about 3150 m, an elevation somewhat lower than the paramo meadows, the site was a luxuriant subalpine forest abounding with mosses and epiphytes, including orchids and bromeliads. Collections were made here with human bait and by light traps.

In Chapman's (1917) outline of the life zones of the Colombian Andes, these collecting sites fall within the upper levels of the Subtropical Zone and the lower Temperate Zone. In Espinal's and Montenegro's (1963) outline of the plant formations of Colombia, based on the Holdridge world system of classification, these sites would be classified as "very humid low montane forest," "low montane rain forest," and "montane rain forest." We are much indebted to Sr. Espinal for his kindness in furnishing us an ecological description of the areas in which these collecting sites are located. From this account the following two paragraphs are abstracted.

West of the town of El Tambo, on the route from Popayan to Guapi, Department of Cauca, the terrain is, first, a series of undulating hills at an elevation of 2000 to 2500 m, where the original "very humid low montane forest" has been replaced by grasslands for cattle grazing. The average annual rainfall here is between 2500 and 3000 mm, and the average temperature between 15° and 17° C. Above 2500 m, the Cerro de Munchique of the western cordillera rises abruptly to a very rainy mountain region classified as "low montane rain forest" (average annual rainfall above 4000 mm), where the trees are covered with dense growth of mosses, lichens, and epiphytes.

The road crossing the central cordillera east of Popayan passes through the region known as the Paramo de Puracé. On the steep slopes, natural forest still remains; the trunks and branches, thickly covered with mosses, lichens, bromeliads, aroids, and vines, reflect the very humid conditions (average annual rainfall above 2000 mm and average temperature below 12° C) of the "montane rain forest." Common trees of these mountain slopes are *Weinmannia* (encenillo), *Clusia* (chagualo), and *Orepanax*. Cleared areas are covered with broad and long-leaved grasses such as *Chusquea* (chusque) and *Neurolepsis*, mixed with *Blechnum* (bushy ferns) and *Espeletia* (frailejon), and boggy and marshy places are covered with mats and cushions of

TABLE 1.—*Mean values of characters of high altitude Colombian* Culicoides

Species	wing length (mm)	costal ratio	tibial spines	antennal ratio	antennal sensoria	palpal ratio	mandibular teeth	P/H ratio
Subg. *Avaritia* (Andicola Group)								
andicola	1.51	0.62	5	1.17	3, 11–15	2.7	15	1.00
orjuelai	1.52	0.63	5	1.27	3, 11–15	3.5	25	1.08
puracensis	1.33	0.62	5	1.15	3, 13–15	3.6	17	1.00
Subg. *Culicoides* (Covagarciai Group)								
popayanensis	2.16	0.68	6	0.86	3, 11–15	3.9	19	0.88
Subg. *Diphaomyia*								
marinkellei	1.61	0.58	4	0.87	3, 8–10	2.9	13	0.83
Subg. *Oecacta*								
monticola	1.31	0.57	4	0.95	3, 11–14	2.0	15	0.65
andinus	1.35	0.57	4	0.82	3, 13–15	2.3	11	0.60
caucaensis	1.83	0.65	4	0.99	3, 9–14	3.0	20	0.85
tamboensis	1.23	0.61	4	0.85	3, 11–14	2.0	11	0.75

Polytrichum moss and *Sphagnum*. In the meadows are bunches of the grass *Cortaderia* species and shrubby *Hypericum* and *Senecio;* in the ravines are *Gunnera* (hoyas de Pantano), lichens, and mosses.

Our terminology and classification follow essentially that presented by Wirth and Blanton (1959) in their paper on the *Culicoides* of Panama, to which the reader is referred for a fuller discussion. We recognize that the dipterous antenna is 3-segmented and that the "segmentation" of the flagellum is secondary, but, nevertheless, for convenience we prefer to use the term "segment" for all 15 divisions of the *Culicoides* antenna. The antennal ratio (table 1) is obtained by dividing the combined lengths of the distal five elongated segments by the combined lengths of the preceding eight. The palpal ratio is the length-

to-greatest-breadth ratio of the third segment. The P/H ratio is the value obtained by dividing the distance from the interocular seta base to the torma by the distance from the torma to the top of the labrum-epipharynx. Wing length is measured from the basal arculus to the wing tip; costal ratio is the value obtained by dividing the distance from the basal arculus to the end of the costa by the wing length. Measurements are of single specimens unless values are presented as mean value (minimum–maximum, n=number of measurements).

The types of our new species are deposited in the U.S. National Museum in Washington, D.C.; when available, paratypes will be deposited in the British Museum (Natural History) in London, in the Department of Preventive Medicine and Public Health of the Universidad el Valle in Cali, Colombia, in the Department of Parasitology and Tropical Medicine of the Universidad de Los Andes in Bogotá, Colombia, and in the Department of Hygiene and Public Health of the Universidade de São Paulo, Brazil.

Subgenus *Avaritia* Fox

Species of the subgenus *Avaritia* are characterized by a broad wing with short, broad radial cells, the tip of the second radial cell being at least slightly included in the poststigmatic pale spot; wing markings variable, often diffuse at least distally, cell M4 without pale area bordering veins M3+4 and Cu1; wing macrotrichia sparse or absent; third palpal segment usually slender, nearly always with a small, round distal sensory pit, the portion beyond the pit not narrowed; thorax unicolorous dark brown, scutum frequently with a pair of sublateral blackish areas or vittae; eyes contiguous, with or without interfacetal hairs; antennae usually with segments not greatly tapered distally, usually with sensorial pattern of III, IX–XV. Two spermathecae present plus a rudimentary third and a small sclerotized ring on the duct. Male genitalia variable; parameres separate, the bases not knobbed but with stout laterally directed process; aedeagus often with heavier sclerotization across the basal arch and with internal median sclerotized peg distally.

Andicola Group

This new group differs from the two previously known groups of American *Avaritia* as follows: from the Neotropical Pusillus Group the species differ in their much larger size, dark legs, broad radial cells, and longer costa, and in their geographical restriction to the temperate higher altitudes; from the Holarctic Obsoletus Group they differ in their hairy eyes, stronger radial venation, and darker wing infuscation.

In addition to the three Colombian species described below, this group is known to include an undescribed Costa Rican species that closely resembles *C. puracensis*, new species, in wing pattern, but differs in having the antennal sensorial pattern III, XI–XV, pale rings on each side of the dark knees, and the costa distinctly thickened proximad of the tip of vein R1.

Culicoides andicola Wirth and Lee, new species

FIGURES 1*a–c*; PLATE 1 (FIG. 1)

FEMALE.—Length of wing 1.51 (1.30–1.58, n=8) mm.

Head: Eyes hairy, contiguous, meeting for a distance equal to the diameter of 2 facets. Antenna (fig. 1*a*) with lengths of flagellar segments in proportion of 18–13–14–14–15–15–15–16–21–23–25–31–46, antennal ratio 1.17 (1.13–123, n=6); XI–XV all stout to apices; distal sensory tufts present on segments III, XI–XV, sometimes also on VII and IX. Palpal segments (fig. 1*b*) with lengths in proportion of 7–27–26–10–17; third segment slightly swollen distally, 2.69 (2.5–2.9, n=8) times as long as greatest breadth, with a small, round, deep sensory pit. Proboscis moderately long, P/H ratio 1.0; mandible with 15 (14–17, n=14) teeth.

Thorax: Unicolorous dark brown. Legs pale brown, femora darker except distally on midfemur; knee spots dark brown on fore- and hind legs; tibiae paler proximad; hind tibial comb with 5 spines, the one nearest the spur longest.

Wing (pl. 1: fig. 1): Pattern as figured; with large, moderately distinct pale spots; large pale area over basal arculus; large pale area over r-m crossvein broadly extending from costal margin into pale area basally in cell M2; poststigmatic pale spot large and quadrate, covering distal half of second radial cell and touching vein M1; distal pale spot in cell R5 rounded with faint margins and not meeting wing margin or vein M1; small, oval, pale spot in base of cell M1 forming a double spot with distal extension of large pale areas filling cell M2 between medial and mediocubital forks; distal pale spot in cell M1 extending proxmad as a sharp point to about middle of cell, the distal side of the spot not meeting wing margin but extending caudad and continuous with the small distal pale spot in cell M2; cell M4 with a large pale spot filling distal half of cell between vein M3+4 and wing margin; anal cell with pale base continuous with pale area over basal arculus, a broad subapical pale band continuous with pale area behind medial fork and extending broadly to posterior wing margin. Macrotrichiae very sparse and confined to distal fourth of wing; costa extending to 0.62 (0.59–0.63, n=8) of distance to wing tip; radial cells of subequal lengths, with distinct lumens, the second much broader. Halter pale.

Abdomen: Dark brown. Spermathecae (fig. 1*c*) 2 plus rudimentary spermatheca and ring; subequal, each measuring 0.047 x 0.036 mm; deeply sclerotized, ovoid, tapering to short sclerotized necks.

Male.—Unknown.

TYPES.—Holotype female: Lago Buey, Paramo de Puracé, Cauca, Colombia, 3250 m, Oct. 28, 1964, V. H. Lee, biting man, USNM type no. 69396. Paratypes, 20 females: 9 females, same data as type; 11 females, 28.4 km east of Puracé, 3100 m, Feb. 18, 1965, V. H. Lee, at light.

REMARKS.—This is the most brightly marked of the three Andean species of *Avaritia*, and is distinguished easily from the others by the definite pointed distal pale spot in cell M1 and by the proximally pale tibiae. Structurally, *C. andicola* closely resembles *C. orjuelai*, new species, with sensorial pattern III, XI–XV, and wing length 1.51 mm, but differs from that species in its broader third palpal segment, lower antennal ratio, and fewer mandibular teeth.

Culicoides orjuelai Wirth and Lee, new species

FIGURES 1*d–g*; PLATE 1 (FIG. 2)

FEMALE.—Length of wing 1.52 (1.47–1.58, n=3) mm.

Head: Eyes hairy, contiguous (fig. 1*d*), meeting for a distance equal to the diameter of 2 facets. Antenna (fig. 1*e*) with lengths of flagellar segments in proportion of 17–12–12–12–13–13–15–15–22–22–26–29–42, antennal ratio 1.27 (1.25–1.28, n=3); XI–XV all stout to apices; distal sensory tufts present on III, XI–XV. Palpal segments (fig. 1*f*) with lengths in proportion of 6–29–22–12–13; third segment slightly swollen distally, 3.5 (2.8–46, n=3) times as long as greatest breadth, with small, round, shallow, distal sensory pit. Proboscis moderately long, P/H ration 1.08; mandible with 25 (23–29, n=6) teeth.

Thorax: Unicolorous dark brown. Legs dark brown, tibiae without proximal pale rings; hind tibial comb with 5 spines, the one nearest the spur longest.

Wing (pl. 1: fig. 2): Pattern as figured; pale areas much reduced; a very faint pale area over basal arculus; a small pale spot centered on r-m crossvein, not extending anteriorly past radius; poststigmatic pale spot in cell R5 very small and oblique, transverse, including only distal fourth of second radial cell; a very faint indistinct pale area distally in anal cell. Macrotrichia very sparse and scattered on distal half of wing including some in cell M4; costa extending to 0.63 (0.62–0.65, n=3) of distance to wing tip; radial cells subequal in length, with distinct lumens, the second much broader. Halter pale.

Abdomen: Dark brown. Spermathecae (fig. 1*g*) 2 plus rudimentary spermatheca and ring; slightly unequal, measuring 0.055 x 0.036 mm

and 0.049 x 0.038 mm; ovoid, tapering to moderately long sclerotized necks.

MALE.—Unknown.

TYPES.—Holotype female: 18 km east of Puracé, 3320 m, Paramo de Puracé, Cauca, Colombia, Oct. 29, 1964, V. H. Lee, at light, USNM type no. 69397. Paratypes, 11 females: 1 female, Lago Buey, 3250 m, Oct. 28, 1964, V. H. Lee, biting man; 10 females, 28.4 km east of Puracé, 3100 m, Feb. 18, 1965, V. H. Lee, at light.

REMARKS.—This species is similar to *C. puracensis*, new species, but can be separated from it by the narrower poststigmatic pale spot,

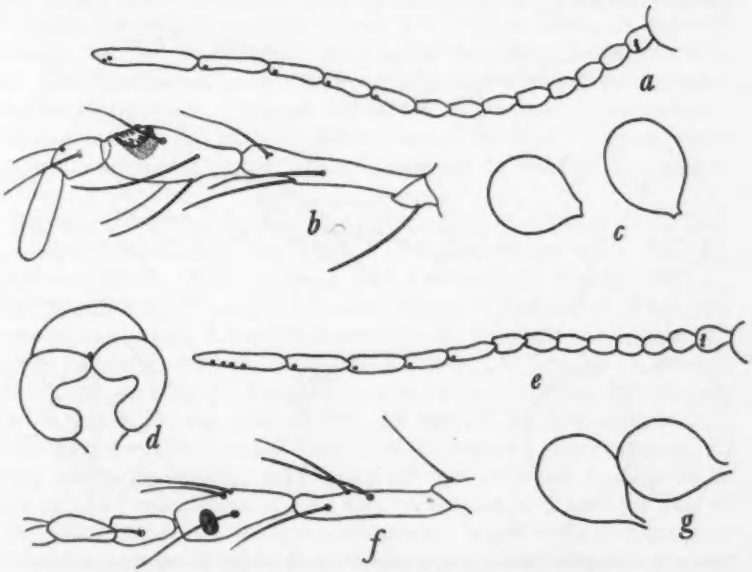


FIGURE 1.—*Culicoides andicola*, new species, female: *a*, antenna; *b*, palpus; *c*, spermathecae. *Culicoides orjuelai*, new species, female: *d*, eye separation; *e*, antenna; *f*, palpus; *g*, spermathecae.

by the presence of sensoria on antennal segments XI and XII, and by the broader apex of XI.

We take pleasure in naming this species after Sr. Pablo A. Orjuela, in recognition of his many years of devotion to the tasks of field research in Colombia.

Culicoides puracensis Wirth and Lee, new species

FIGURE 2; PLATE 1 (FIG. 3)

FEMALE.—Length of wing 1.33 (1.22–1.40, n=14) mm.

Head: Eyes hairy, contiguous (fig. 2*b*), meeting for a distance equal to the diameter of 2 facets. Antenna (fig. 2*a*) with lengths of flagellar

segments in proportion of 16–11–12–13–13–13–13–14–17–18–22–27–39, antennal ratio 1.15 (1.09–1.19, n=7); XI with distinct preapical constriction; distal sensory tufts on segments III, XIII–XV, occasionally also on XII. Palpal segments (fig. 2*c*) with lengths in proportion of 7–24–26–13–14; third segment very slender, 3.6 (3.2–4.3, n=16) times as long as greatest breadth (4.3 in holotype), with a small, round, deep, distal sensory pit. Proboscis moderately long, P/H ratio 1.0; mandible with 17 (16–20, n=28) teeth.

Thorax: Unicolorous dark brown. Legs dark brown, tibiae without proximal pale rings; hind tibial comb with 5 spines, the one nearest the spur longest.

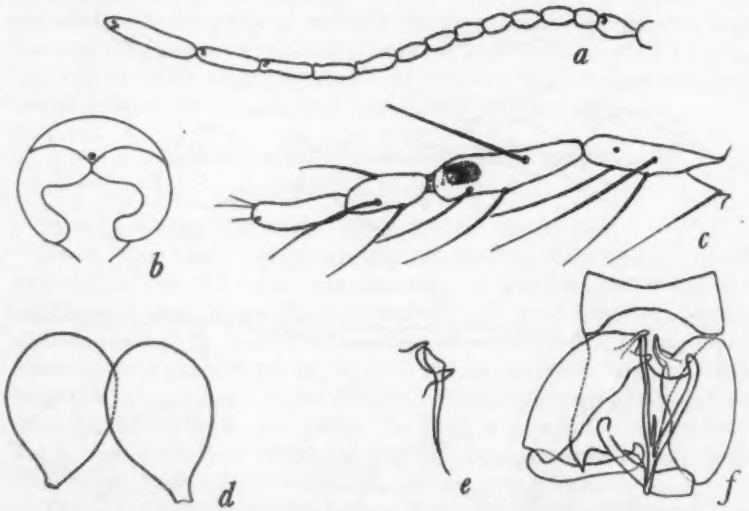


FIGURE 2.—*Culicoides puracensis*, new species, female (except as noted): *a*, antenna; *b*, eye separation; *c*, palpus; *d*, spermathecae; *e*, male paramere; *f*, male genitalia, parameres not shown.

Wing (pl. 1: fig. 3): Pattern as figured; 3 anterior pale spots, variable in size and intensity, a variable one over basal arculus, second over r–m crossvein and meeting costal margin broadly and media slightly (sometimes much reduced as in specimen figured); third or poststigmatic spot covering apex of second radial cell, broad and quadrate and extending caudad three-quarters way to vein M1; an indistinct pale area midway in cell M2 between medial and mediocubital forks; pale spots absent in distal parts of cells R5 and M2, no pale spots in cell M1; a moderately large, fairly distinct pale spot distally in cell M4 and a slightly smaller pale spot distally in anal cell near mediocubital stem in anterior half of cell. Macrotrichia very

sparse along wing margins in distal portions of cells R5, M1, and M2; costa extending to 0.62 (0.59–0.70, n=14) of distance to wing tip, radial cells of subequal lengths, with distinct lumens, the second much broader. Halter pale.

Abdomen: Dark brown. Spermathecae (fig. 2*d*) 2 plus rudimentary spermatheca and ring; slightly unequal, measuring 0.067 x 0.048 mm, and 0.062 x 0.046 mm, deeply sclerotized, ovoid, tapering to short sclerotized necks.

MALE.—As in the female with the usual sexual differences; wing length 1.37 mm; costal ratio 0.62; palpal ratio 2.9. Genitalia as figured (fig. 2*e–f*): Ninth sternum with broad, shallow, caudomedian excavation, the ventral membrane bare; ninth tergum elongate, tapered distally, with short, pointed, apicolateral processes. Aedeagus with very low basal arch, sides nearly straight and tapering to elongate, slender distal stem; internal, subapical, sclerotized point present. Parameres each (fig. 2*e*) with short, stout anterolateral process, midportion slender and nearly straight, tapering to slender, filamentous tip.

TYPES.—Holotype female: Lago Buey, 3250 m, Paramo de Puracé, Cauca, Colombia, Feb. 18, 1965, V. H. Lee, biting man, USNM, type no. 69398. Allotype male: 28.4 km east of Puracé, 3100 m, Feb. 18, 1965, V. H. Lee, at light. Paratypes, 87 females on slides, 500 females in alcohol: 8 females, same data as holotype; 11 females on slides, 250 in alcohol, same data as allotype; 250 females in alcohol, same data as allotype but biting man, Feb. 17, 1965; 68 females, 18 km east of Puracé, 3320 m, Oct. 29, 1964, V. H. Lee, at light.

REMARKS.—This species resembles *C. orjuelai*, new species, in wing markings, but the pale spot over r-m crossvein is variable in size and the poststigmatic pale spot is broader and involves less of the second radial cell, the spermathecae are larger and more unequal, and the antennae differ, having the sensorial pattern III, XIII–XV and the distal constriction of XI. This is by far the commonest of the Paramo species, and the numbers taken in the biting collections attest to its annoyance to human beings.

Subgenus *Culicoides* Latreille

Species of the subgenus *Culicoides* are most numerous in the North Temperate Zone, especially in the colder north latitudes under subarctic conditions. They do occur down the western cordilleras of North America through Central America at higher elevations, i.e., *C. luteovenus* Root and Hoffman and *C. elutus* Macfie. In Central America a characteristic group has evolved, the Covagarciai Group.

Most species of the subgenus *Culicoides* are large blackish species with prominent wing pattern that includes a pale spot at the tip of the

second radial cell, antennal sensoria usually on segments III, XI–XV, the hind tibial comb with 5–6 spines, and 2 well-developed spermathecae present.

Covagarciai Group

This group consists of large- to medium-sized species with legs yellow or with the knees broadly yellow banded; scutum yellowish to brown, subshining; base of cell M4 dark at the base of the mediocubital fork, and apices of veins M1, M2, M3+4 and Cu1 always dark; eyes contiguous, bare; male genitalia with basistyles mesally spinose, apicolateral processes of the ninth tergum developed to varying degrees, and variable development of lobes or a cleft on the caudal margin between them. There are five previously described species found in Central America and northern South America.

Culicoides popayanensis Wirth and Lee, new species

FIGURE 3; PLATE 1 (FIG. 4)

FEMALE.—Length of wing 2.16 (1.90–2.43, n=14) mm.

Head: Eyes (fig. 3*b*) bare, contiguous for a distance equal at least to the diameter of 3 facets. Antenna (fig. 3*a*) with lengths of flagellar segments in proportion of 32–28–30–31–33–30–28–28–30–34–40–46–68, antennal ratio 0.86 (0.82–0.91, n=3); distal sensory tufts present on segments III, XI–XV, 5–7 sensoria on distal half of XV; antenna brownish III–X with extreme bases of segments pale. Palpal segments (fig. 3*c*) with lengths in proportion of 12–32–40–19–19; third segment moderately swollen in midportion 3.9 (3.6–4.5, n=14) times as long as greatest breadth, with an open irregular pit subapically. Proboscis moderately long, P/H ratio 0.88; mandible with 19 (16–21, n=28) teeth.

Thorax: Brown, scutum with a submedian pair of large yellowish-brown patches on discal area. Legs brown; knees and distal fourth of femora yellow, narrow base of foretibia and approximately basal halves of mid- and hind tibiae yellow, hind tibia with broad apex pale; hind tibial comb (fig. 3*c*) with 6 spines, the second from the spur longest.

Wing (pl. 1: fig. 4): Pattern as figured; pale spots extensive with a yellowish tint; anterior margin with 3 very dark areas; wing base pale for a distance of approximately one-third the length of medial stem; broad yellowish pale spot over r-m crossvein, broadly meeting costal margin and extending narrowly into cell M2; poststigmatic pale spot involving distal two-thirds of second radial cell, extending distally only slightly past it into cell R5, barely touching vein M1 posteriorly, branches of media and cubitus with apices dark at wing margin; a moderately large pale area straddling vein M2 just proximad

of midlength, but the vein itself continuing as a dark line through this spot; cell M1 with 1 distal pale spot, located at about its length from wing margin; cell M2 with a large pale area lying between medial and mediocubital forks, a large rounded distal pale spot attaining wing margin; no pale area in base of mediocubital fork, a large rounded pale spot distally in cell M4, broadly meeting wing margin but not touching vein M3+4; a large transverse, double pale spot distally in anal cell, the posterior portion sometimes very faint. Macrotrichia moderately sparse on distal third of wing and continued proximally in cell M2 and nearly to base of anal cell; costa

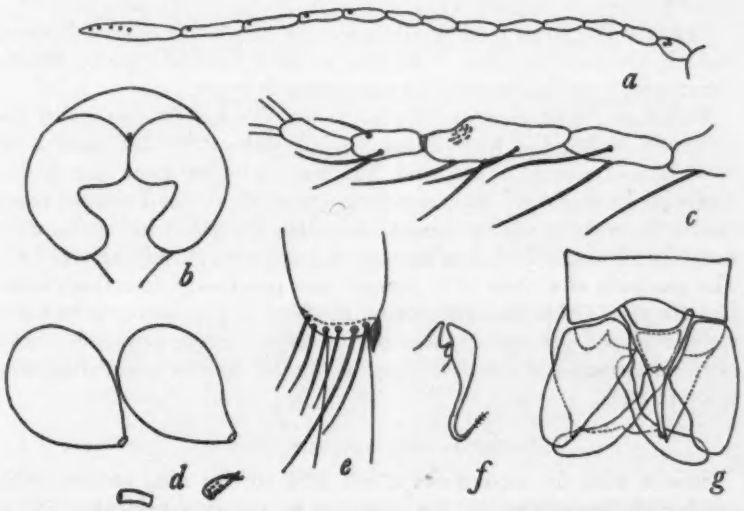


FIGURE 3.—*Culicoides popayanensis*, new species, female (except as noted): *a*, antenna; *b*, eye separation; *c*, palpus; *d*, spermathecae; *e*, hind tibial comb; *f*, male paramere; *g*, male genitalia, parameres not shown.

extending to 0.68 (0.65–0.71, n=14) of distance to wing tip; radial cells with distinct lumens, the second broader and about twice as long as first. Halter pale.

Abdomen: Dark brown. Spermathecae (fig. 3*d*) 2 plus a rudimentary third and a long sclerotized ring; subequal, each measuring 0.065 x 0.046 mm, ovoid, tapering gradually to variable, short, sclerotized necks.

MALE.—Similar to the female with the usual sexual differences; wing length 2.07 mm; antennal plume sparse, last 3 antennal segments with lengths in proportion of 75–72–70. Genitalia (figs. 3*f*, *g*)

as figured; ninth tergum rounded caudad, indistinctly bilobed, apicolateral processes short and moderately prominent, widely separated; ninth sternum with very slight caudomedian excavation, the ventral membrane not spiculate; basistyle moderately stout, mesal margin with numerous small but moderately prominent setae, ventral and dorsal roots short and blunt; dististyle long and curved with a stout rounded tip. Aedeagus with very low basal arch, midportion broad a short distance, then tapered gradually to a long slender distal stem with a small ball-like tip. Parameres separate, each (fig. 3*f*) with a short, stout anterolateral process, midportion swollen a short distance, tapered distally to a long, slender filament bearing minute hairs distally.

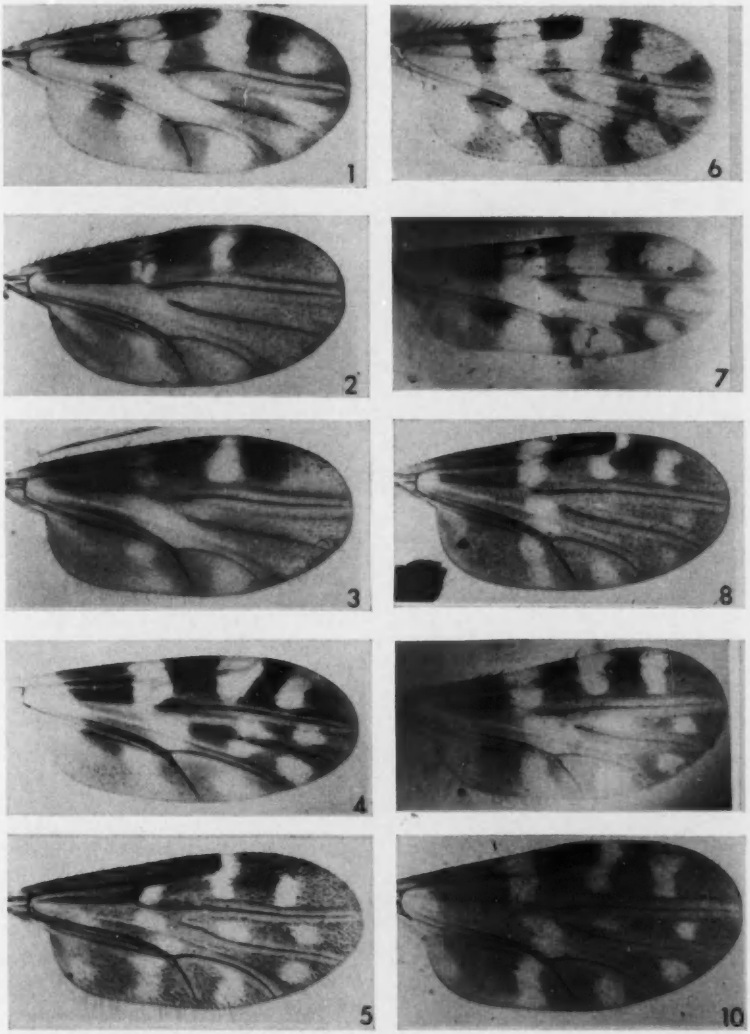
TYPES.—Holotype female, allotype male: 28.4 km east of Puracé, 3100 m, Cauca, Colombia, V. H. Lee, at light, USNM type no. 69399. Paratypes, 2 males, 70 females: same data as types.

REMARKS.—This species belongs to the Covagarciai Group of the subgenus *Culicoides*, with knees broadly yellow banded, and it is most like *C. marshi* Wirth and Blanton. It differs from the latter, however, in its larger size, slenderer legs with 6 tibial spines, more gradually tapering spermathecae, less extensive pale wing spots, with vein M2 forming a dark line through the pale spot straddling vein M2. The genitalia of a male of *C. marshi* (not previously described) from Rio Raposo, Colombia, differ from those of *C. popayanensis* in their well-developed submedian lobes on the ninth tergum similar to those of *C. metagonatus* Wirth and Blanton (figured in Wirth and Blanton, 1959, p. 306).

Subgenus *Diphaomyia* Vargas

Species with the second radial cell dark to tip; wing pattern with small, definite pale spots, the pale spot at r-m crossvein often lying entirely distad of crossvein, vein M1 often with pale spots lying adjacent anteriorly in cell R5, veins M1 and M2 often with pale spots straddling them or lying adjacent to the vein, pale spot in cell M4 usually extending along vein M3+4; 2 spermathecae plus rudimentary third and small sclerotized ring; spermathecae oval in shape with long slender necks; male genitalia with pair of characteristic posterior sclerotized processes on posterolateral "shoulder" of aedeagus; parameres with basal knob and distal portion with lateral fringing barbs.

In Wirth and Blanton (1959), the three previously known Neotropical species, *C. blantoni* Vargas and Wirth, *C. evansi* Wirth and Blanton, and *C. iriartei* Fox, were placed in the Iriartei Group of the subgenus *Oecacta*. These species can be placed conveniently in Vargas' (1960) subgenus *Diphaomyia*, with type species *C. baueri* Hoffman.



FIGURES 1–10.—Wings of *Culicoides*, new species (magnifications not to same scale): 1, *andicola*; 2, *orjuelai*; 3, *puracensis*; 4, *popayanensis*; 5, *marinkellei*; 6, *monticola*; 7, *andinus*; 8, *caucaensis*; 9, *tamboensis*, male; 10, same, female.

TOP: A paramo meadow at Paramo de Puracé, Colombia, sloping gradually to Lago Buey at 3250 meters elevation (site 2, photo by V. H. Lee). BOTTOM: Margin of a paramo meadow with frailejón plants (*Espeletia* sp.) prominent in the foreground at about 3000 meters. A slope with a thick forest of low trees and brush is in the right background, the ground covered with a deep litter of branches, vines, mosses, etc. (site 3, photo by M. Kuns).

The species described below is probably more closely allied to the North American *C. haematopotus* Malloch and *C. baueri* Hoffman than to the other three Neotropical species.

Culicoides marinkellei Wirth and Lee, new species

FIGURE 4; PLATE 1 (FIG. 5)

FEMALE.—Length of wing 1.61 (1.55–1.70, n=13) mm.

Head: Eyes bare, broadly separated (fig. 4*b*), the interocular space with a long seta. Antenna (fig. 4*a*) with lengths of flagellar segments in proportion of 18–14–16–18–18–17–17–16–18–18–21–23–38, antennal ratio 0.87 (0.82–0.91, n=7); distal sensory tufts present on segments

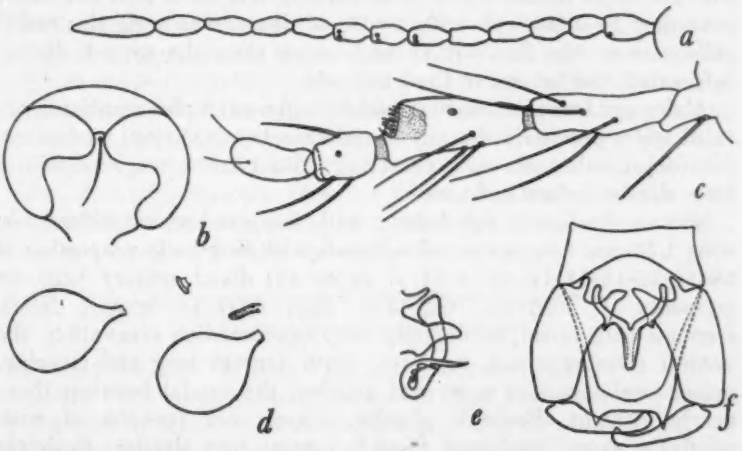


FIGURE 4.—*Culicoides marinkellei*, new species, female (except as noted): *a*, antenna; *b*, eye separation; *c*, palpus; *d*, spermathecae; *e*, male paramere; *f*, male genitalia, parameres not shown.

III, VIII–X, rarely also on VII. Palpal segments (fig. 4*c*) with lengths in proportion of 9–23–25–12–14; third segment slightly swollen distally, 2.9 (2.5–3.2, n=13) times as long as greatest breadth, with a small, round, deep, apical sensory pit. Proboscis short, P/H ratio 0.83; mandible with 13 (12–15, n=25) teeth.

Thorax: Dark brown; scutal pattern not discernible in slide-mounted specimens. Legs dark brown, knee spots blackish, tibiae with narrow sub-basal pale rings; hind tibial comb with 4 spines, the second from the spur longest.

Wing (pl. 1: fig. 5): Pattern as figured; second radial cell dark to tip; membrane very deeply infuscated and pale spots small and

definite; small pale spot lying just distad of r-m crossvein, the crossvein dark; a small transverse poststigmatic pale spot not attaining vein M1 posteriorly; 1 small transverse pale spot in middle of distal portion of cell R5, not meeting wing margin or vein M1; 2 pale spots in cell M1, the proximal one touching vein M2 posteriorly, the distal one lying far from wing margin; 2 separate pale spots in proximal portion of cell M2, one of which lies behind medial fork, the other just in front of mediocubital fork; only 1 pale spot in distal portion of cell M2, lying near but not meeting wing margin; cell M4 with a round pale spot with an anteroproximal extension a short distance along vein M3+4; anal cell with an indistinct pale spot in anal angle and a large, transverse double pale spot in distal portion. Macrotrichia coarse and numerous distad of r-m crossvein and over all of anal cell; costa extending to 0.58 (0.57–0.59, n=13) of distance to wing tip; radial cells narrow, the first slitlike and longer than the second. Halter infuscated, the flat end of the knob pale.

Abdomen: Dark brown. Spermathecae (fig. 4*d*) 2 plus a rudimentary third and a peculiarly shaped, flangelike, sclerotized ring; moderately sclerotized, subequal, each measuring 0.053 x 0.035 mm, oval with a long, slender, sclerotized neck.

MALE.—Similar to the female, with the usual sexual differences; wing 1.53 mm long; antennal segments with lengths in proportion of 38–14–14–14–14–14–14–14–14–17–52–42–46; distal sensory tufts on segments III, VIII–XII. Genitalia (figs. 4*e,f*) as figured: Ninth sternum with broad, moderately deep caudomedian excavation, the ventral membrane not spiculate; ninth tergum long and tapering, apicolateral processes short and angular, the caudal between them nearly straight. Basistyle slender, dorsal root foot-shaped with relatively short "toe" and "heel," ventral root slender; dististyle slightly curved, slender, with bent, pointed tip. Aedeagus with short, broad, rounded, basal arch extending to less than half of total length; "shoulders" each with a short posterior sclerotized process typical of *Diphaomyia;* distal stem parallel sided with bluntly rounded tip. Parameres each (fig. 4*e*) with blackish basal knob, midportion slender and slightly curved with a low ventral lobe distally; distal portion much slenderer, tapering distally to terminal filament and bearing a lateral fringe of 5–6 coarse barbs.

TYPES.—Holotype female: Lago Buey, 3250 m, Paramo de Puracé, Cauca, Colombia, Oct. 28, 1964, V. H. Lee, biting man, USNM type no. 69400. Allotype male: 18 km east of Puracé, 3320 m, Oct. 29, 1964, V. H. Lee, at light. Paratypes, 63 females: 61, same data as holotype; 2, same data as allotype.

REMARKS.—This species is distinguished readily by its wing pattern of definite small pale spots on a very dark ground, with the pale spot

at the r–m crossvein lying entirely distal of the crossvein. Its closest Neotropical relative is *C. iriartei* Fox, a lowland species that has similar male genitalia but within which the wing pattern is much different, with the pale spot centered over the r–m crossvein and a double pale spot distally in cell R5. The North American *C. baueri* Hoffman and *C. haematopotus* Malloch have very similar male genitalia, but these also differ greatly in wing pattern.

We are very pleased to name this species in honor of Dr. C. J. Marinkelle, parasitologist at the Universidad de los Andes in Bogota, Colombia, in recognition of his keen interest in Colombian haematophagous Diptera.

Subgenus *Oecacta* Poey

As it stands, this subgenus is a heterogeneous assemblage of species groups that cannot yet be assigned definitely to the existing subgenera in which the second radial cell is dark to the apex. In the strict sense, this subgenus should be restricted to those species resembling the type species, *C. furens* (Poey), with two well-developed spermathecae, a rudimentary third and a ring; antennal sensoria on segments III, VIII–X, or similar pattern, none on XI–XV; and male genitalia with long apicolateral processes on the ninth tergum, and a strong basal knob and subapical fringing spines on the parameres.

Culicoides monticola Wirth and Lee, new species

FIGURES 5*a–d*; PLATE 1 (FIG. 6)

FEMALE.—Length of wing 1.31 (1.23–1.39, n=7) mm.

Head: Eyes bare, narrowly separated (fig. 5*a*), interocular space above with a seta-less tubercle. Antenna (fig. 5*b*) with lengths of flagellar segments in proportion of 18–15–16–17–17–16–16–16–20–21–25–25–34, antennal ratio 0.95 (0.93–0.98, n=3); distal sensory tufts present on segments III, XI–XIV; III–X prominently bicolored, the narrow apices dark, XI–XV all dark. Palpal segments (fig. 5*d*) with lengths in proportion of 11–18–24–8–12; third segment distinctly swollen, 2.0 (1.8–2.3, n=8) times as long as greatest breadth, with a moderately large, deep, round sensory pit opening by a smaller pore. Proboscis short, P/H ratio 0.65; mandible with 15 (13–16, n=11) teeth.

Thorax: Brownish, scutum with prominent markings of large yellowish areas. Legs dark brown with very prominent markings; knee spots blackish, all femora with subapical and all tibiae with sub-basal, narrow pale rings, hind tibia with distal half pale; hind tibial comb with 4 spines, the one nearest the spur longest.

Wing (pl. 1: fig. 6): Pattern as figured; with very prominent pattern of large pale spots coalescing transversely to form 5 irregular pale

bands across wing; second radial cell very dark to tip; base of wing pale to level slightly past one-half the distance from basal arculus to r–m crossvein; large spot over crossvein forming a pale band extending to mediocubital fork; poststigmatic pale spot broader than the dark spot distal to it, continued posteriorly as a pale band continuous with pale distal area in cell M4, the portion in cells M1 and M2 slightly displaced distad of anterior and posterior ends; apex of wing with 3 large separate pale spots, the one in cell R5 broadly meeting wing margin anterodistally, the extreme posterodistal corner of cell R5 dark;

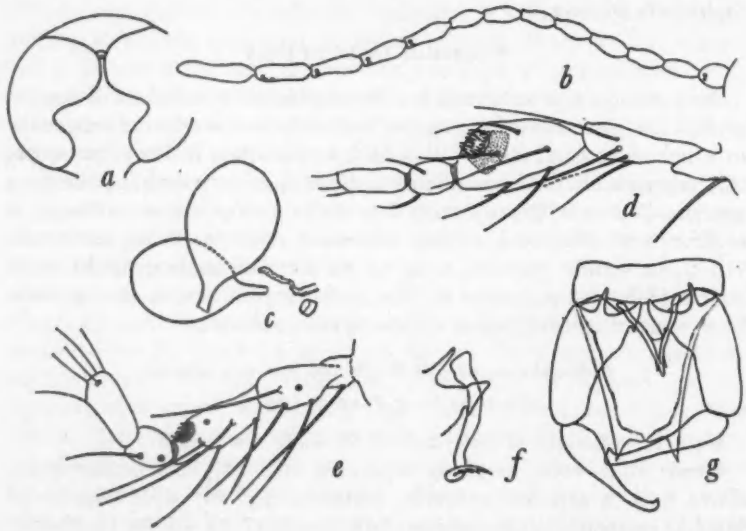


FIGURE 5.—*Culicoides monticola*, new species, female: *a*, eye separation; *b*, antenna; *c*, spermathecae; *d*, palpus. *Culicoides andinus*, new species, male: *e*, palpus; *f*, paramere; *g*, genitalia, parameres not shown.

an elongate, oval, pale spot distally in cell M1, not quite meeting wing margin; a rounded pale spot filling apex of cell M2; 2 separate pale spots in distal part of anal cell; no pale spots at apices of veins M1, M2, M3+4, or Cu1. Macrotrichia numerous distad of a line between end of costa and base of mediocubital fork, forming a double row to base of cell M2, and scattered in anal cell; costa extending to 0.57 (0.57–0.58, n=7); second radial cell much shorter than the first, with broad lumen, the first slitlike. Halter pale.

Abdomen: Dark brown. Spermathecae (fig. 5*c*) 2 plus a rudimentary third and a sclerotized ring; unequal in size, measuring 0.065 x 0.043

mm and 0.061 x 0.050 mm, slightly ovoid, with long, slender, sclerotized necks.

MALE.—Unknown.

TYPES.—Holotype female: Finca Carpenteria, El Tambo, Cauca, Colombia, 2500 m, July 8, 1964, V. H. Lee, tent trap, USNM type no. 69401. Paratypes, 6 females: 4, same data as type; 2, same data except July 9, 1964, in light trap.

REMARKS.—This species and the next (for their separation see the discussion of *C. andinus*) are closely related to each other, but are not closely related to any other known Neotropical species, probably coming closest to the Limai Group. The wing pattern of large pale spots centered in the cells forming 4 or more less complete transverse pale bands across the wing is similar to that of the North American *C. crepuscularis* Malloch and other species of the subgenus *Beltranmyia* Vargas, which, however, have only 1 spermatheca and differ in many other characters.

Culicoides andinus Wirth and Lee, new species

FIGURES 5*e–g*; PLATE 1 (FIG. 7)

FEMALE.—Length of wing 1.35 mm.

Head: Eyes bare; nearly contiguous, with a wedge-shaped interocular space bearing a seta-less tubercle above. Antenna with lengths of flagellar segments in proportion of 19–16–17–17–17–16–16–16–18–19–22–22–29, antennal ratio 0.82; distal sensory tufts present on segments III, XIII–XV; segments III–X bicolored but the narrow, dark apices not as prominent as in *C. monticola*. Palpal segments with lengths in proportion of 7–22–23–7–9; third segment short and only moderately swollen, 2.3 times as long as greatest breadth, with a small, round, shallow sensory pit. Proboscis short, P/H ratio 0.60; mandible with 11–12 teeth.

Thorax: Dark brown; scutum without prominent pattern. Legs brownish, knee spots blackish; femora with narrow, subapical pale rings, faint on hind leg; tibiae with narrow, sub-basal pale rings, hind tibia dark distally; hind tibial comb with 4 spines, the 2 nearest the spur longer, subequal in length.

Wing: Pattern nearly as in *C. monticola;* the 2 middle sets of pale spots not coalesced in complete bands; second radial cell dark to tip; pale area over base of wing extending to one-half the distance between basal arculus and r-m crossvein; pale spot over r-m crossvein large and quadrate, extending only slightly into cell M2; poststigmatic pale spot in cell R5 quadrate, not meeting vein M1; distal pale spot in cell R5 large, broadly meeting anterior wing margin, leaving apical corner of cell dark; cell M1 with 2 elongate, oval pale spots, the

proximal one longer; cell M2 with large pale area between medial and mediocubital forks broadly separated from pale basal area of wing continued distally as a narrow streak to level of pale spot in cell M4, a small round pale spot at apex of cell not quite meeting wing margin; cell M4 with large, round pale spot nearly filling distal portion of cell; anal cell with 1 large pale spot in distal portion; apices of veins M1 and M2 faintly pale at wing margin. Macrotrichia numerous on distal portion of wing, continued proximally through anal cell and in a double row to base of cell M2; costa extending to 0.57 of distance to wing tip; radial cells with distinct lumens, the second much broader and slightly shorter than the first. Halter infuscated.

Abdomen: Dark brown. Spermathecae 2 plus a rudimentary third and a ring; subequal, each measuring 0.065 x 0.040 mm, slightly ovoid with long, slender, sclerotized necks.

MALE.—Similar to the female, with the usual sexual differences. Wing length 1.33 mm; costal ratio 0.55; distal 5 antennal segments with lengths in proportion of 13–17–48–37–29; palpal segments (fig. 5*e*) with lengths in proportion of 6–15–19–8–13; pale wing pattern (pl. 1: fig. 7) more extensive than in female, the pale spots coalescing on disc of wing to form 2 complete middle transverse bands, pale spots at apices of veins M1 and M2 conspicuous. Genitalia (figs. 5*f*, *g*): Ninth sternum without caudomedian excavation, the ventral membrane not spiculate; ninth tergum long and tapering, the apicolateral processes long and slender, the caudal margin between them transverse. Basistyle long and slender, ventral root "foot-shaped," dorsal root slender; dististyle slender with distally bent tip. Aedeagus with high basal arch extending to over one-half of total length, the ventral arms nearly straight, forming with the tapering distal stem a V-shaped structure, stem slender distally with a pair of very faintly sclerotized subapical points. Parameres each (fig. 5*f*) with strong basal knob, midportion slender, slightly sinuate, without ventral lobe, distally narrowed and curved ventrad with a subapical fringe of 3–4 fine barbs.

TYPES.—Holotype female, allotype male: Finca Carpenteria, El Tambo, Cauca, Colombia, 2500 m, July 9, 1964, V. H. Lee, light trap USNM, type no. 69402. Paratypes: 1 female, 18 km east of Puracé, 3320 m, Oct. 29, 1964, V. H. Lee, at light; 1 male, 28.4 km east of Puracé, 3100 m, Feb. 18, 1965, V. H. Lee, at light.

REMARKS.—This species is very closely related to *C. monticola* but can be distinguished readily by its reduced, pale wing markings, with only 1 pale spot distally in anal cell, the palpal pit shallower with pore not narrowed, sensorial pattern III, XIII–XV, dark halter, and dark apices of hind femur and tibia.

***Culicoides caucaensis* Wirth and Lee, new species**

FIGURES 6*a–d;* PLATE 1 (FIG. 8)

FEMALE.—Length of wing 1.83 (1.69–1.92, n=4) mm.

Head: Eyes with very short interfacetal hairs; very narrowly separated (fig. 6*b*), interocular space above with a seta-less tubercle.

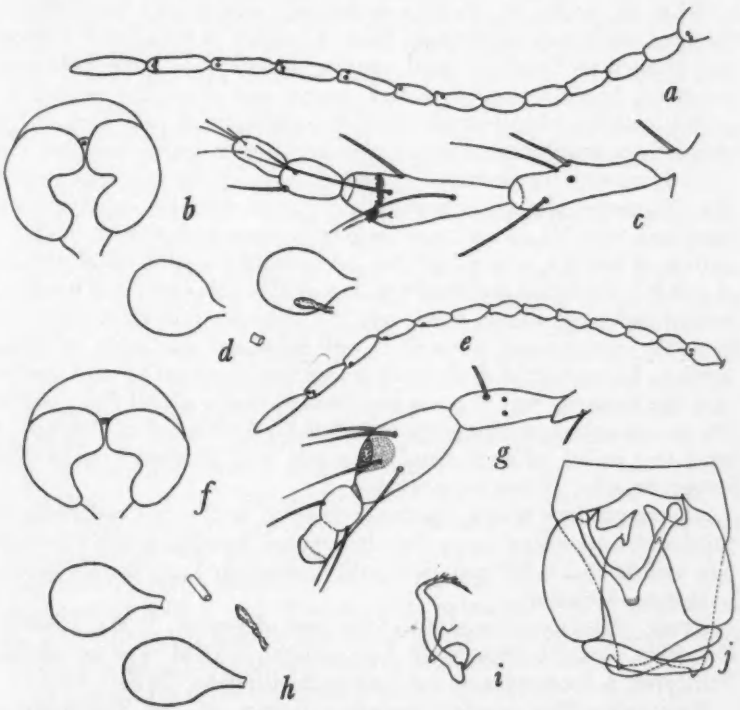


FIGURE 6.—*Culicoides caucaensis*, new species, female: *a*, antenna; *b*, eye separation; *c*, spermathecae; *d*, palpus. *Culicoides tamboensis*, new species, female (except as noted): *e*, antenna; *f*, eye separation; *g*, palpus; *h*, spermathecae; *i*, male paramere; *j*, male genitalia, parameres not shown.

Antenna (fig. 6*a*) with lengths of flagellar segments in proportion of 21–17–18–19–19–20–21–18–27–30–30–30–37, antennal ratio 0.99; distal sensory tufts present on segments III, IX–XIV. Palpal segments (fig. 6*d*) with lengths in proportion of 9–26–29–10–10; third segment moderately swollen distally, 3.0 (2.8–3.2, n=4) times as long as greatest breadth, with a broad, irregular sensory pore distally. Proboscis

moderately long, P/H ratio 0.85; mandible with 20 (18–22, n=8) teeth.

Thorax: Brown; scutum without discernible pattern in slide-mounted specimens. Legs brownish, hind tibia with narrow, sub-basal pale ring; hind tibial comb with 4 spines, the one nearest the spur longest.

Wing (pl. 1: fig. 8): Pattern as figured; very deeply brownish infuscated, with only moderately distinct pattern of pale spots: a small one lying just distad of basal arculus; a pale spot lying over r–m crossvein, broadly meeting costal margin and extending caudad to media; cell R5 with 2 small separate poststigmatic pale spots lying obliquely to each other, the one on anterior with margin smaller, the other lying slightly proximad of end of costa; distal pale spot in cell R5 transverse, slightly concave distally, not meeting anterior wing margin or vein M1; 1 very faint pale spot, sometimes absent, in distal portion of cell M1, a very faint one, sometimes absent in distal portion of cell M2, the latter proximally with a double pale spot lying between medial and mediocubital forks; cell M4 with very indistinct pale spot in distal portion; anal cell with 2 very indistinct pale spots in distal portion. Macrotrichia moderately numerous, confined to area distad of a line between end of costa and base of mediocubital fork, plus a few in anal cell; costa extending to 0.65 (0.60–0.67, n=4) of distance to wing tip; radial cells subequal in length, with distinct lumens, the second broader. Halter infuscated.

Abdomen: Dark brown. Spermathecae (fig. 6*c*) 2 plus a rudimentary third and a sclerotized ring; slightly unequal, measuring 0.049 x 0.030 mm and 0.045 x 0.030 mm, oval with moderately long, slender necks.

MALE.—Unknown.

TYPES.—Holotype female: 28.4 km east of Puracé, 3100 m, Cauca, Colombia, Oct. 29, 1964, V. H. Lee, at light, USNM type no. 69403. Paratypes, 5 females: same data except 2 with date "18 Feb. 1965."

REMARKS.—This species resembles species of the Transferrans Group in general features but differs in the possession of 2 spermathecae. Its exact systematic affinities, therefore, remain in doubt. Superficially it is very similar to *C. puracensis* and *C. orjuelai* in the subgenus *Avaritia*, but its palpal structure, eye separation, spermatheca shape, and number of tibial spines readily distinguish it from members of that group.

Culicoides tamboensis Wirth and Lee, new species

FIGURES 6*e–j*; PLATE 1 (FIG. 9–10)

FEMALE.—Length of wing 1.23 mm.

Head: Eyes hairy, very narrowly separated (fig. 6*f*), the interocular space with a seta-less tubercle. Antenna (fig .6*e*) with lengths of

flagellar segments in proportion of 17–14–16–17–17–17–17–17–19–19–21–22–31, antennal ratio 0.85; distal sensory tufts present on segments III, XI–XIV, 4 sensoria on XIV. Palpal segments (fig. 6*g*) with lengths in proportion of 7–19–22–8–6; third segment short and swollen, 2.0 times as long as greatest breadth, with a small, deep sensory pit. Proboscis short, P/H ratio only 0.75; mandible with 11 teeth.

Thorax: Brown; scutum with moderately distinct pattern, which in slide-mounted specimen appears to include many small brown punctures around the seta bases; scutellum yellowish on slides. Legs pale brown; blackish knee spots present on all legs; fore- and midfemora with narrow subapical pale rings, all tibiae with narrow sub-basal pale rings and hind tibia with apex pale; hind tibial comb with 4 spines, the one nearest the spur longest.

Wing (pl. 1: fig. 10): Pattern as figured; second radial cell dark to apex; with moderately distinct pale spots as follows: a moderately large pale area just distad of basal arculus; a somewhat transverse pale spot centered on r-m crossvein and extending from costa to media; a single oblique poststigmatic pale spot extending posteriorly only three-quarters the breadth of cell R5; a transverse subapical pale spot in cell R5 reaching neither anterior nor posterior cell margins; 2 small pale spots in cell M1, the distal one much distant from wing tip; cell M2 with a distinct double pale area lying between medial and mediocubital forks, a distinct, small, round pale spot near wing margin in tip of cell, but no spot between these pale spots; cell M4 with round pale spot near apex; anal cell with single transverse pale spot extending from near mediocubital fork to posterior wing margin. Macrotrichia very sparse on distal half of wing, none extending proximad of level of end of costa; costa extending to 0.61 of distance to wing tip; radial cells with distinct lumens, the second moderately broad. Halter not visible in slide-mounted specimen examined.

Abdomen: Dark brown. Spermathecae (fig. 6*h*) 2, subequal, moderately large, ovoid with long, slender, sclerotized necks; rudimentary spermatheca and elongate sclerotized ring present.

TYPE.—Holotype female: Finca Carpenteria, El Tambo, Cauca, Colombia, 2500 m, July 9, 1964, V. H. Lee, light trap, USNM type no. 69404.

REMARKS.—A male specimen (from the Paramo de Puracé, 28.4 km east of Puracé, Cauca, Feb. 18, 1965, V. H. Lee, at light) is thought to be the male of *C. tamboensis*, because of the following similarities: Eyes hairy; wing 1.20 mm long, pattern (pl. 1: fig. 9) as figured, very similar to the female but with the poststigmatic pale spot broader and not as oblique, the pale spot lying immediately in front of mediocubital fork not distinct, the distal pale spot in anal cell extending quite broadly to wing margin. The scutum is darker than in the female

and appears to lack the pattern of dark punctures over the hairs; leg banding as in the female, but hind tibia dark to tip. Halter with base of knob dark, the end pale. Third palpal segment very short and broad; antenna with flagellar segments in proportion of 30–24–12–12–12–11–11–10–11–11–40–35–38; distal tufts present on XIII and XIV. Genitalia as figured (figs. 6*i*, *j*): Ninth sternum with very shallow caudomedian excavation, the ventral membrane not spiculate; ninth tergum with short, pointed apicolateral processes. Basistyle with "foot-shaped" ventral root, a distinct "heel" present; dorsal root slender; dististyle long and slender, with bent pointed tip. Aedeagus with broad basal arch extending to two-thirds of total length, the basal arms strongly sclerotized and irregularly convex laterally; distal stem short with bluntly rounded tip. Parameres each (fig. 6*i*) with strong basal knob, main portion slightly sinuate and moderately stout, no ventral lobe present; distal portion gradually narrowed, abruptly twisted to sharp distal point and bearing a lateral subapical fringe of 5–6 fine spines.

This species is very similar to *C. caucaensis*, new species, but is much smaller in size, there is only one poststigmatic pale spot in cell R5, only one distal pale spot in anal cell, and the distal pale spots in cells M1, M2, and M4 are quite distinct; sensoria are not present on antennal segments IX and X, and the palpal pit is small and deep.

References

CHAPMAN, F. M.
1917. The distribution of bird-life in Colombia: A contribution to a biological survey of South America. Bull. American Mus. Nat. Hist., vol. 36, 729 pp.

ESPINAL, L. S., and MONTENEGRO, E.
1963. Formaciones vegetales de Colombia. Bogotá: Dept. Agrológico. Inst. Geogr. Agustín Codazzi, 201 pp.

FORATTINI, O. P.
1957. *Culicoides* da Região Neotropical (Diptera, Ceratopgonidae). Arq. Fac. Hig. Saúde Publ. Univ. São Paulo, vol. 11, pp. 161–526.

VARGAS, L.
1960. The subgenera of *Culicoides* of the Americas (Diptera, Ceratopogonidae). Rev. Biol. Trop., vol. 8, pp. 35–47.

WIRTH, W. W., and BLANTON, F. S.
1959. Biting midges of the genus *Culicoides* from Panama (Diptera: Heleidae). Proc. U.S. Nat. Mus., vol. 109, pp. 237–482.

U.S. GOVERNMENT PRINTING OFFICE: 1967